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UP-STREAM ENGINEERING

By Harry E. Reddick, Regional Conservator

The term "up-stream engineering" is perhaps unusual, although like most terms pertaining to conservation, it is by no means new. It is unusual for several reasons, and the outstanding one in the case of the United States is that it has been adopted by a nation before the over-density of population and the inevitable complexities of existence drove us to it. Up-stream engineering is and has been for many centuries an accepted practice among many of the more heavily populated nations and would certainly have been adopted in this nation within a century or less for the same reason that has driven other peoples from the fertile valleys onto the steep slopes for subsistence.

Conservation 1905

How does it happen that in September, 1930, a conference was called to discuss a phase of engineering that would be considered unusual to millions of American citizens? The answer should begin by giving credit to a similar conference held thirty years ago. In 1905, Theodore Roosevelt called such a conference; and as a result of that gathering the U. S. Forest Service was established, and a systematic program of observation and study of problems pertaining to conservation was started. That was more than thirty years ago, but the years that followed that notable gathering of 1905 were by no means idle ones. Accurate, scientifically conducted experiments were carried on throughout the nation relative to run-off, erosion, flood control, and many other phases pertaining to the conservation of the same natural resources which we are considering today.

Influence of Research

It was not so much the feeling that definite knowledge was lacking that prompted the conference as it was that much of this carefully collected information was not available. Much research had been carried on by independent agencies, and as a result its effect, although great in its entirety, was so scattered that it had not influenced land use to any appreciable extent.

Up-Stream Engineering Conference

Thirty years after the first organized attempt by Theodore Roosevelt to apply scientific study to the problems of conservation, another man - another Roosevelt - called for a conference of up-stream engineering to be held in Washington, D. C., in September, 1936. Perhaps his motives may best be explained by quoting in part from a letter by him to the Honorable Henry A. Wallace, Secretary of Agriculture, and dated June 10, 1936. "Up-stream engineering will have a major part in efforts to save the land and control floods, and for that reason it offers a broad field of opportunity for the engineering profession. I am therefore in hearty accord with your suggestion that there be held an open conference on the subject in early fall ..... There are indications that a substantial body of technical information on the control of little waters is now available in the scattered records of American experience - Federal, State and professional. The urgent problem is to bring these data together in a coordinate body of engineering knowledge so that public officials and engineers may have a more definite picture of the up-stream engineering as an important field of public and professional activity.....The objects of up-stream engineering are through forestry and land management to keep water out of our streams, to control its action once in the stream and generally to retard the journey of the raindrop to the sea. Thus the crests of down-stream floods are lowered."

Scientific Forestry

Scientific forestry was probably the first step in the right direction on this continent, and in the beginning it was considered capable of playing a lone hand in coping with the problem by retarding run-off. At that time, no broad understanding of the hydrologic cycle had been generally realized. Now we are able to approach problems of soil and water control in a more rational manner, because we perceive that any one point within the cycle is not a thing by itself, but is related to other points throughout the complete cycle.

Lack of Organized Knowledge

In accepting up-stream engineering as a necessary coordinated attempt to influence the physical aspects of man's environment, one must realize that too frequently in the past conditions in the head-water areas have been considered as acts of God. One must further realize that there has been in the past a deplorable lack of organized knowledge on the subject and any definition of up-stream engineering must involve an integration of engineering knowledge covering all of many related physical factors pertaining to a drainage area. After all, it can never be denied that a beaver-like retarding dam back on a farm creek and a towering Norris dam on a trunk stream are both parts of the same complexity of engineering.

The Necessity of Up-Stream Engineering

The necessity of up-stream engineering is emphasized by the many attempts to control run-off in the down-stream areas as by any other one thing. The fact that man has finally raised his eyes both figuratively and literally toward the upper watersheds becomes surprising only in his tardiness when we compile the millions of acres ruined by erosion, the thousands of reservoirs made useless by deposition, and the amount of property lost and the number of lives sacrificed because of floods.

Age-Long Practices

Undoubtedly, the most urgent reason for up-stream engineering dates back to the age-long practices of using water from streams for domestic purposes. No city in the past was ever founded without due and careful consideration of its water supply. The heretofore unaccountable disappearance of such supplies has been costly and frequently tragic chapters in the histories of growing cities and nations.

Water for Irrigation

The second reason for up-stream engineering is the absolute necessity of water for irrigation in a great many of the most fertile and productive areas of our nation. As an illustration of this important phase of the subject, it has been pointed out that 80 percent of the water supply for the state of Utah comes from above 7,000 feet elevation; and as an indication of the potential benefits to be derived from up-stream engineering, it has further

been pointed out that if methods can be applied to the watershed of one Utah river in such a way that it would delay the peak flow ten days, it would cut in half the water deficiency for the entire year in the irrigated fields below and would save $2,000,000 a year in this one district.

Hydro-electric Power

The third benefit to be derived from up-stream engineering is by insuring a constant source of hydro-electric power. Today, the banks of the mountain streams in America are dotted with the abandoned turbines that have been starved through the deposition of silt in their storage reservoirs.

Recreation and Wildlife

The fourth benefit to be derived from this program pertains to recreation and wildlife. The American public has recently discovered that there has been a startling depletion of wildlife throughout the nation. Up-land birds have either migrated permanently or have been starved out by the disappearance of springs. Wild fowl no longer nest in the dry wastes that were once their feeding grounds, and which were fed by a constant seepage from the upper watersheds.

America Today

The picture of America today, from a standpoint of natural resources, is far from a pretty one - especially if we think for but a moment of what it was three generations ago, and what it is likely to be three generations hence. There is probably no event in the history of our country comparable in both its dramatic effect and tragic meaning to the sudden nation-wide consciousness of erosion as a problem that followed in the wake of the dust storms a year or two ago. We are all too familiar with the colossal depredations of erosion in the United States to justify any lengthy recounting of known facts. Millions of gullies ripping the land from coast to coast. Thousands of families driven from their homes, leaving multiple thousands of raw, wind-swept subsoil areas to await the creeping edges of an inland desert. All these are too well known to possibly qualify as news, but what is not well known is that all this happened for two reasons, as quoted from Hugh H. Bennett, Chief of the Soil Conservation Service: "Ignorance with respect to the seriousness

of the problem, and, the physical impossibility of combating it in any effective way by piece-meal or single project method, in which only one implement such as hill-side ditching or hill-side terraces is employed."

The Problem Involved

As has been emphasized by every authority who has made a careful and analytical study of soil or water conservation, the greatest problem involved is directly related to mankind's stubbornness in refusing to think beyond tomorrow.

Perhaps the second greatest problem involved was pointed out by President Roosevelt when he referred to a lack of coordination in the land use studies and land use practices that have been carried on.

Vastness of Nation

The vastness of our nation itself and the radically differing climates involved become an important part of the problem to such an extent that the purpose of up-stream engineering reverses as it goes from east to west. In the east, the goal of the engineer is to successfully rid the land of the water; but in the more arid sections he must, first of all, attempt to hold as much water on the land as possible, after which he considers ways and means of safely removing the excess.

To say that these are all the problems involved would be as much in error as it would be to continue delaying our challenge of floods, and erosion until after the water has gathered and gained momentum in its charge toward the low lands.

There are many others - some based on economics, some on custom, and some on laws that have grown out of custom. Some problems we can see today, but others can only be revealed by work and intelligence.

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FITTING THE SOIL TO THE CROP

By Cornelius G. Ullman, Regional Agronomy Division

It is a general concept that crops must be adapted to suit the soil and other environmental conditions. However, the adapting of the soil to suit the crop, particularly by the use of adequate soil conservation practices, has been observed only by those farm operators familiar with the underlying principles of soil and its management.

Topsoil is Dynamic

These individuals realize that the topsoil is the dynamic body of the earth's surface which provides the necessary elements for plant growth and that soil losses means depreciation in their investment. Witness to such losses are dilapidated and abandoned farm and ranch houses surrounded by gullies and stark weed-grown fields barren of topsoil. Such land once produced profitable crops.

Soil Conservation

Tillage, planting, and harvesting are not the only duties of the farmer. Conservation of soil and soil fertility are basic practices which determine the profitable life of both crop and man on the land. There is no man-made law which determines how private lands should be farmed. Man has determined his own destiny on the land by his ideas of its proper use. The monuments of millions of acres of totally useless eroded land is evidence that man's ideas are not always correct.

Significance of Erosion

In California, the diversity of climate and soil conditions and the advantages imputed to certain crops thereby has resulted in the use of much land on which erosion is a serious menace. Many operators and owners of farms, beginning to realize the significance of the erosion problem as an important factor in the preservation of their investment in the land and crops, have taken steps, often at a very considerable expense, to provide adequate means for adapting the soil to the crops by measures and practices involving conservation of the soil and its fertility against the encroachment of the forces of erosion.

Bench Terraces

Examples of this are seen in the hillside citrus groves of Southern California planted on

grade-contour-bench terraces, with berms or risers perennially vegetated to prevent soil washing and filling of benches below. Citrus requires certain climatic advantages for peak production, quality and flavor. Locations, such as found on normally frost-free foothill slopes, where such conditions operate, are naturally very valuable. However, without adequate soil and soil nutrients for proper growth and fruitfulness, such locations would be worthless for citrus production. Growers owning and operating groves on these areas are awake to the fact that the soil must be conserved in order to take advantage of the climatic factors. The results are seen in the examples given above.

Communities in which such practices are established have necessarily high economic and soil standards. Homes and dwellings are modern, new cars are prevalent, and children attend high schools and colleges.

Decreased Yields

Contrasted with the previous conditions are the very many more areas seriously endangered by erosion where no attempt has been made to adapt the soils to the crop grown. No provisions for soil erosion control or soil management has been made. On these lands, even though a valuable climatic advantage for the production of the specific crop exists, yields have steadily decreased with the increasing loss of topsoil. Finally, because of the inroads of erosion, and in many instances in order to prevent washing and deposition of infertile subsoil on fertile less-sloping land below, the once profitable crop area is abandoned for the production in many cases of crops less suitable and profitable, but more adapted to the eroded and impoverished condition of the soil.

Poor Land Crops

E. N. Fergus writing in the Journal of the American Society of Agronomy points out that the choosing of poor land crops to suit the impoverished condition of the soil actually impoverishes the land still further. Such crops are usually of poor quality and may be deficient in minerals. Reports of animals showing malnutrition have been in many cases traced to poor land forage crops deficient in mineral content.

Green Manure Crop

However, where such crops are not pastured off or cut for hay, but instead incorporated as green manure crop, a step will have been made toward the rebuilding of the soil. If this practice had been used in proper rotation with the cash crop during all the years that erosion was taking its toll of the soil resources unobserved, the acute conditions brought about through accelerated and man-made erosion necessitating the abandonment of a profitable crop area would not have arisen.

Erosion Dissipates Capital

This loss of a productive part of the farm handicaps and jeopardizes the whole farm business. Interest and taxes have to be met from a smaller or less profitable enterprise. The owner's capital is slowly dissipated with the ultimate result of bankruptcy, foreclosure, or a sheriff's sale.

Proper Land Use

If, early in the history of such farms, proper land use practices by adapting the soil to the crop through terracing, ditching, contour tillage, and proper crop rotations, had been established, the present situation could not have developed. Such measures, the utility of which is being demonstrated by the work of the Soil Conservation Service, requires considerable expenditures. However, this conclusion must be made: expenditures for soil conservation looking toward the adaptation of the soil to the crop are just as much an investment and improvement in potentially erosive land as the improvement of level land by installation of irrigation systems, checking, levelling, or the planting of an orchard. Without soil conservation and the resulting adaptation of soil to crops, the loss of soil and soil fertility on erodible land very quickly depreciates the investment in land, as well as any improvements made thereon.

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ANNUAL GRADE DITCHES

Annual Ditches

Practically all annual grade ditches were completed in the Sebastopol area before the beginning of rainfall near the end of December. These ditches have functioned exceedingly well. Apple leaves, that had blown into the ditches, were removed to keep the channels open.

NATION-WIDE SCOPE OF SOIL CONSERVATION SERVICE PROGRAM

Figures recently released from the Washington office, quoted below, are an impressive example of the magnitude of the Soil Conservation Service program. The work of the Service in California and Nevada is part of this vast endeavor that is seeking to keep the good land good. Those who are on demonstrational areas have a day-by-day opportunity to cooperate in this program. It is heartening to know that farmers all over the nation are working hand-in-hand with the Government to curtail sheet and gully erosion which has ruined many acres of once productive land.

Total number of projects	156
Total number of states with projects	43
Total number of projects on private land	152
Total number of projects on public land (Large watersheds)	4
Approximate total acreage covered by all Service projects	53,600,000
Approximate total acreage covered by private land projects	6,966,000
Approximate total acreage covered by Federal land projects	46,600,000
Total number of SCS-CCC Camps	450
Total number of states with camps	38
Approximate working area of each camp - acres	25,000
Approximate total working area of SCS-CCC Camps	11,375,000
Approximate total area covered by SCS projects & SCS-CCC Camps	64,975,000
Total number of Service nurseries	64
Total number of States with nurseries	34
Total number of Service experiment stations	19
Total number of states with experiment stations	15

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SOIL CONSERVATION PROGRAM AIDS WILDLIFE

Thousands of trees, shrubs, and other plants are being set out on demonstrational areas. Wherever practical they are selected for the dual purpose of holding the soil and providing shelter and food for game. Highly erodible land is being turned back to native vegetation on some areas and watering places for the game are being provided by cooperators.

Regulated grazing and modified farm practices are helping to give game birds and other desired species of wildlife a chance to re-establish themselves.

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SUBSOILING

Outstanding demonstrations of the beneficial effects of subsoiling were made in southern California projects in December. Subsoiling on all slopes on the contour resulted in a marked reduction in erosion on all fields and in some completely eliminated it.